Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.1 Recall that matter is made up of particles too small to be seen.
Taxonomy level: 1.2-B Remember Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of matter being made up of particles too small to be seen in previous grades. Students will further develop this concept in 7th grade (7-5.1) when they identify these particles as atoms.

It is essential for students to know that matter is anything that has mass and takes up space (has volume) and that all matter is made up of very small particles too small to be seen. Even though these particles are very small, they cause matter to have its basic properties.

It is not essential for students to know the name of these particles; there is no study of atoms at this time.

Assessment Guidelines:
The objective of this indicator is to *recall* that matter is made up of particles too small to be seen; therefore, the primary focus of assessment should be to remember this information from memory. However, appropriate assessments should also require students to *identify* matter as being made up of very small particles; or recall that matter has mass and takes up space.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.2 Compare the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles).
Taxonomy level: 2.6-B Understand Conceptual Knowledge

Previous/Future knowledge: In 2nd grade (2-4.1), students recalled the properties of solids and liquids and in 3rd grade (3-4.1) students classified different forms of matter (including solids, liquids, and gases) according to their observable (shape) and measurable (volume) properties. Students have not been introduced in previous grades to the concept of particles of matter and how they are affected by the states of matter. Students will further develop this concept in the 7th grade (7-5.10) as they compare physical to chemical changes.

It is essential for students to know that solids, liquids, and gases can be compared based on their physical properties (including volume, shape, and the movement and spacing of particles):

Solids
- *Solids* have a definite shape and volume.
- Particles in a solid are very close to one another (dense) and vibrate, but stay in the same place.
- The volume of a solid with rectangular sides can be determined by measuring with a ruler and calculating height x width x length.
- The volume of an irregularly shaped solid can be determined by water displacement in a graduated cylinder.
- The volume of water displaced equals the volume of the object.

Liquids
- *Liquids* have a definite volume, but their shape changes according to the shape of their containers.
- The particles are also close to one another, but they are able to move apart from each other and flow from place to place.
- The volume of a liquid can be measured using a graduated cylinder or graduated syringe.

Gases
- *Gases* have no definite shape or volume, but take the shape and volume of their containers, filling the space available.
- The particles easily move far apart from each other and spread out through the available space.

It is because of the movement and spacing of particles of matter that the volume and shape of solids, liquids, and gases differ.

It is not essential for students to know that the volume of a gas changes with pressure changes or how temperature changes can affect volumes of gases, liquids, and solids. Students do not need to know how to measure the volume of a gas.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

Assessment Guidelines:

The objective of this indicator is to *compare* the physical properties of the states of matter; therefore, the primary focus of assessment should be to detect ways the physical properties of solids, liquids, and gases are alike and different, including their volumes, shapes, and movement and spacing of particles. However, appropriate assessments should require students to *interpret* a diagram of particles of matter in solids, liquids, and gases and to *recognize* which diagram of particles is associated with which state of matter based on the movement and spacing of the particles; to *interpret* a diagram of measuring tools to determine the volume of solids or liquids; and to *recognize* which state of matter is described given various physical properties.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.3 Summarize the characteristics of a mixture, recognizing a solution as a kind of mixture.
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of how different materials can be mixed together and then separated again in 2nd grade (2-4.4). The concept of solutions being a kind of mixture is new to this grade level. In the 7th grade (7-5.2), students will further develop the concept of mixtures by distinguishing them from elements and compounds.

It is essential for students to know the characteristics of mixtures.
- *Mixtures* are composed of two or more substances that are mixed together but can be separated from each other.
- Mixtures can be made from various combinations of solids, liquids, or gases.
- The substances in a mixture do not permanently change in the mixture, but they keep their separate properties.

Solutions are one type of mixture is a solution.
- They are composed of substances that mix so completely that they cannot be distinguished as separate substances.
- They can, however, be separated back into the separate substances.
- One example of a solution is a mixture of a solid that dissolves completely in a liquid, for example salt or sugar in water.

It is not essential for students to know that mixtures can be heterogeneous or homogeneous or that they can be distinguished from elements and compounds.

Assessment Guidelines:
One objective of this indicator is to *summarize* the characteristics of mixtures; therefore, the primary focus of assessment should be to generalize major point about the characteristics of mixtures. However, appropriate assessments should also require students to *recognize* a substance as a mixture based on characteristics; or *identify* substances in a mixture based on their properties.

Another objective is to *recognize* that a solution is a kind of mixture; therefore, the primary focus of that objective is to retrieve from memory the fact that solutions are a type of mixture. However, appropriate assessments should also require students to *classify* various substances as mixtures or solutions based on characteristics.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.4 Use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.
Taxonomy level: 3.2-B Apply Procedural Knowledge

Previous/Future knowledge: In 2nd grade (2-4.4), students recognized that different materials can be mixed together and then separated again. They have been introduced to the concept of magnetic attraction in 2nd grade (2-5.1) and in 4th grade (4-5.9) and to the process of evaporation in 3rd grade (3-4.2). Students will further develop the concept of physical changes in 7th grade (7-5.10)

It is essential for students to know and use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures. –

Filtration
- *Filtration* is used to separate solid particles from a liquid.
- For example, pouring the mixture through a filter paper in a funnel will trap the solid particles and only allow the particles of the liquid to pass through.
- This method is used in water treatment plants as part of the process for separating dirt and other solid particles from water to produce clean drinking water.

Sifting
- *Sifting* is used to separate smaller solid particles from larger solid particles.
- For example, the mixture of different sized solid particles can be put into a container that has a screen material at the bottom with holes of a certain size.
- When the mixture is shaken, the smaller particles go through the screen leaving the larger particles in the container.
- Cooks, for example, sift flour to get a small particle size for baking leaving larger particles of flour in the sifter above the screen.
- Sand and gravel companies, for example, separate rocks into different sized particles for road building and other construction projects using this method.

Magnetic attraction
- *Magnetic attraction* is used to separating magnetic material from a mixture of other substances.
- When a magnet is stirred through the mixture, it pulls out the magnetic material from the mixture.
- A cow magnet, for example, is given to a cow to swallow. It stays in the first stomach of the cow keeping magnetic materials like wire and other harmful materials that cows swallow from going into the rest of their digestive system.

Evaporation
- *Evaporation is* used to separate a solid that has dissolved in a liquid solution.
- The solution is heated or left uncovered until all the liquid turns to a gas (evaporates) leaving the solid behind.
- Salt in salt water or ocean water, for example, is separated by heating the solution until all the water evaporates leaving the solid salt in the container.

Chromatography
- *Chromatography* is used to separate and analyze the solutes in a solution.
- For example, a small amount (2-3 drops) of the solution is put on a piece of filter paper, which is put in a solvent.
- The substances in the solution that dissolve most easily travel the furthest; and substances that do not dissolve easily do not travel very far.
- The bands of color that are formed allow scientists to identify the substances in the solution by comparing them to the location of known substances forming bands of color on different filter papers.

Floatation
- *Floatation* is used to separate solids that float from the remaining liquid in a mixture.
- The solids are stirred and when they float to the top, they are skimmed off the surface of the liquid and put into a different container.
- This method is used, for example, in some water purification plants.

It is not essential for students to know that these processes depend on physical changes, not chemical changes.

Assessment Guidelines:
The objective of this indicator is to *use* the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures; therefore, the primary focus of assessment should be to apply the procedures to separate a given mixture. However, appropriate assessments should also require students to *recognize* a given procedure that would be appropriate to separate a given mixture; or *summarize* how to separate a given mixture.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5.4.5 Explain how the solute and the solvent in a solution determine the concentration.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of solutions, solvents, solutes, or concentrations in previous grades. Students will further develop the concepts of mixtures and concentrations in 7th grade (7-5.2 and 7-5.6).

It is essential for students to know that solutions are types of mixtures and that they are defined by the particles in them.

- The substance in a solution that is in the greatest amount is the *solvent*. It is usually the liquid.
- The substance in a solution that is in the least amount is the *solute*. It is usually the solid.

The relationship of the amount of solute to solvent determines the *concentration* of a solution.

- The more solute a solution has compared to the amount of solvent, the more concentrated it is said to be.
- When two solutions contain the same amount of solvent, the one with the greater amount of solute is the more concentrated solution
- In order to make a solution more concentrated, more solute is added.
- To make a solution less concentrated, more solvent is added.

It is not essential for students to know specific quantitative relationships (ratios) of solutes and solvents in specific percent concentrations for solutions.

Assessment Guidelines:

The objective of this indicator is to *explain* how the solvent and solute in a solution determine the concentration; therefore, the primary focus of assessment should be to construct a cause-and-effect model for how the relationship of solvent to solute in a solution determines the concentration. However, appropriate assessments should also require students to *recognize* the solute and solvent in a solution; or to *summarize* how the relationship of solute to solvent can determine the concentration of a solution.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.6 Explain how temperature change, particle size, and stirring affect the rate of dissolving.

Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-4.2), students explained how water and other substances changed from one state to another by adding or removing heat. Students have not been introduced to the concepts of rate of dissolving of solutes in solutions in previous grades. They will further develop these concepts of rate of dissolving in high school Physical Science (PS-3.1).

It is essential for students to know that solutes (solids) dissolve in solvents (liquids) in solutions in different amounts in given times, which is called the *rate of dissolving*. The rate of dissolving can be affected by several factors.

Temperature change

- Usually, if the temperature increases, more of the solute will dissolve faster.

Particle size

- Usually, if the particle sizes are smaller, more of the solute will dissolve faster.

Stirring

- Usually, if the solution is stirred, more of the solute will dissolve faster.

It is not essential for students to know about solubility of solutes or whether a solution is saturated or unsaturated.

Assessment Guidelines:

The objective of this indicator is to *explain* how temperature change, particle size, and stirring affect the rate of dissolving; therefore, the primary focus of assessment should be to construct a cause-and-effect model about how these various factors affect the rate of dissolving. However, appropriate assessments should also require students to *recognize* factors that can increase the rate of dissolving and those that can decrease the rate of dissolving; *infer* how a given factor will affect the rate of dissolving; or *summarize* ways that the dissolving of a solute can be increased.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.7 Illustrate the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: Students have not been introduced to the concept of substances chemically combining in previous grades. In 7th grade, students will further develop this concept of chemical changes and reactions (7-5.9 and 7-5.10).

It is essential for students to know that under certain conditions, substances can chemically combine when they are mixed, and the new substance formed cannot easily be separated into the original components. When substances chemically combine, a new substance is formed that has different properties from the original substances that were mixed to form it.

Some examples in which new substances are formed might include:
- To make a cake, you can mix flour, water, egg, oil, and sugar, but after baking in the oven, the cake has different properties.
- Adding vinegar to baking soda will produce a gas. If the liquid is evaporated, a salt will remain.
- When steel wool is exposed to water, rust is formed.

It is not essential for students to know the conditions for a chemical change or reaction to occur.

Assessment Guidelines:
The objective of this indicator is to *illustrate* the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot be easily separated; therefore, the primary focus of assessment should be to give or use illustrations such as pictures, diagrams, or word descriptions showing that a chemical change has occurred when substances were mixed together. However, appropriate assessments should also require students to *identify* substances that are chemically combined from a mixture because they cannot easily be separated; or *recognize* chemically combined mixtures as new substances that cannot easily be separated.

Properties of Matter

5-4 The student will demonstrate an understanding of properties of matter. (Physical Science)

5-4.8 Explain how the mixing and dissolving of foreign substances is related to the pollution of the water, air, and soil.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-3.1), students were introduced to the concept of sediment when they classified rocks and soils. They were also introduced to Earth's water features (3-3.5). In 4th grade (4-2.6), students explained how organisms cause changes in their environments (for example, humans polluting the air and dumping toxins into waterways). In 7th grade (7-4.6), students will explain the importance of conservation of resources (including water, air, and soil).

It is essential for students to know that foreign substances can mix with and dissolve in water, air, and soil resulting in pollution.

- These foreign substances are often produced as a result of activities associated with industry, agriculture, burning fossil fuels, or other processes associated with human activities.
- The greater the amount of the foreign substance, the more concentrated or harmful the pollution can be.

It is not essential for students to know exactly what kinds of foreign substances are responsible for pollution of water, air, and soil. Students do not need to know about point and nonpoint sources of pollution.

Assessment Guidelines:
The objective of this indicator is to *explain* how the mixing and dissolving of foreign substances is related to the pollution of water, air, and soil; therefore, the primary focus of assessment should be to construct a cause-and-effect model of how foreign substances cause pollution of water, air, or soil pollution when mixed or dissolved in them. However, appropriate assessments should also require students to *recognize* pollution of water, air, and soil as being formed from foreign substances mixed or dissolved in them; or *summarize* the relationship between water, air, and soil pollutions and the mixing and dissolving of foreign substances.